

# Experimental Assessment of the Tuning Characteristics of a Coupled Oscillator Array for Phased Array Antenna Control

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Group

## **WHAT DOES A PHASED ARRAY ANTENNA DO?**

- Steers an antenna beam electronically.
- Beam steering caused by phase change.
- Phase Shifters = commonly used to control phase.
  - Well established science.
- Phase Shifters are:
  - Very accurate
  - Effective
  - Expensive
  - Complicated to use

# COMMUNICATION INFRASTRUCTURE

SYNCHRONOUS  
ORBIT



36,000

LOW  
ORBIT



(BUT POSSIBLE  
AS REEL FEED)



1,000

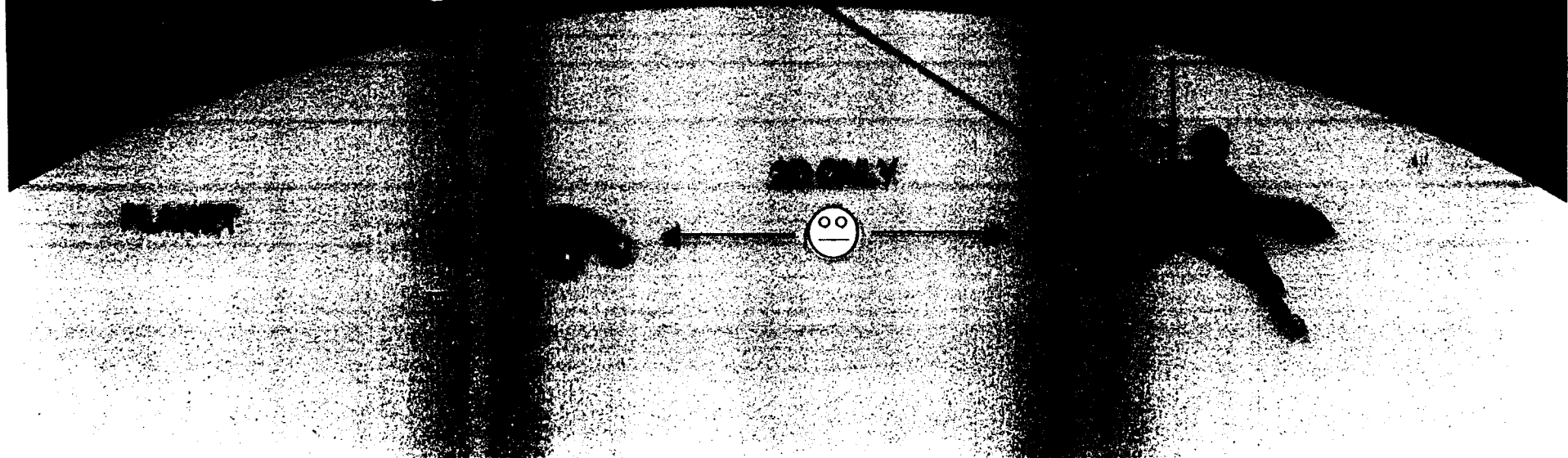
100 OR 200



REEL ONLY



REEL ONLY



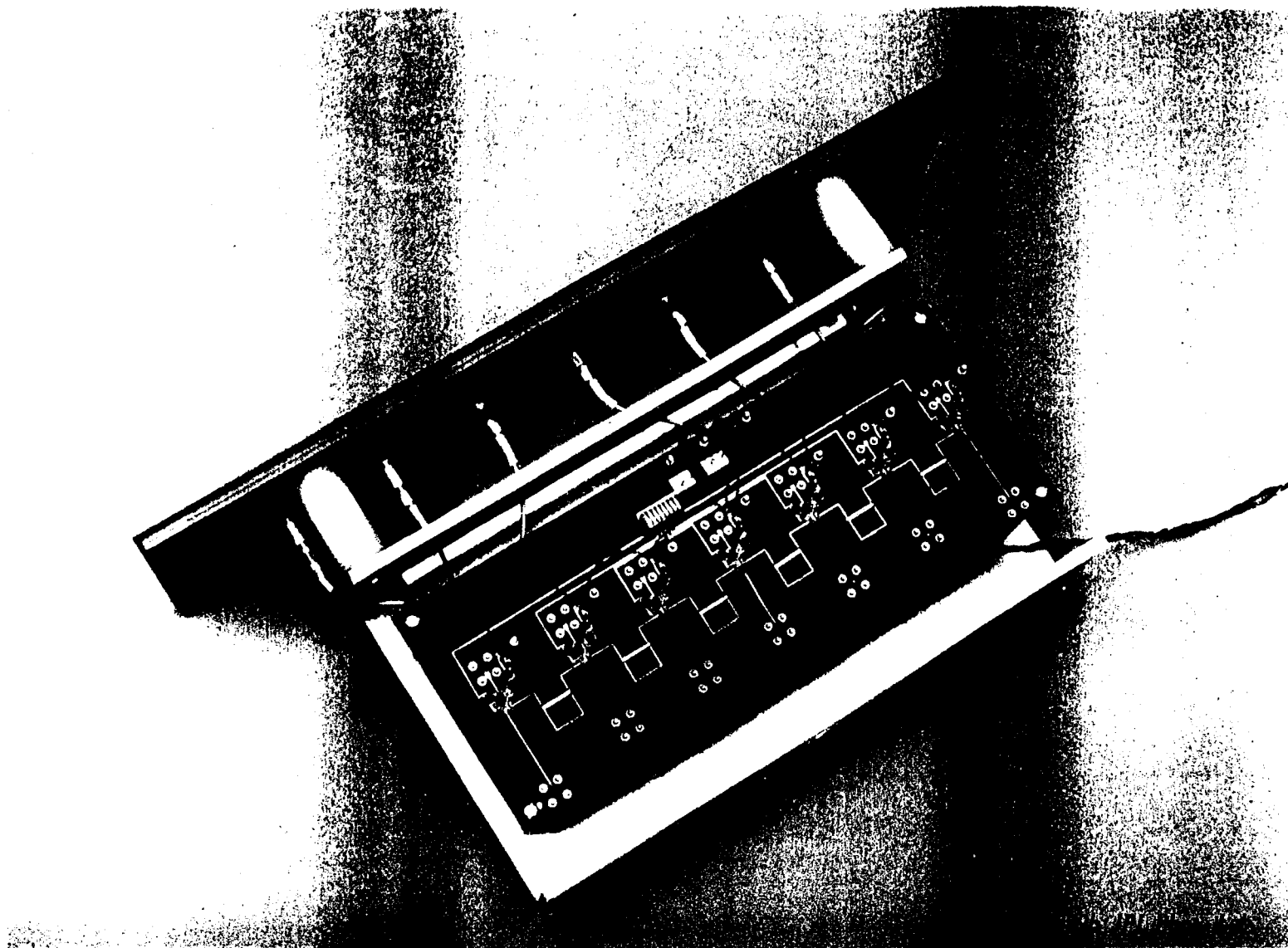


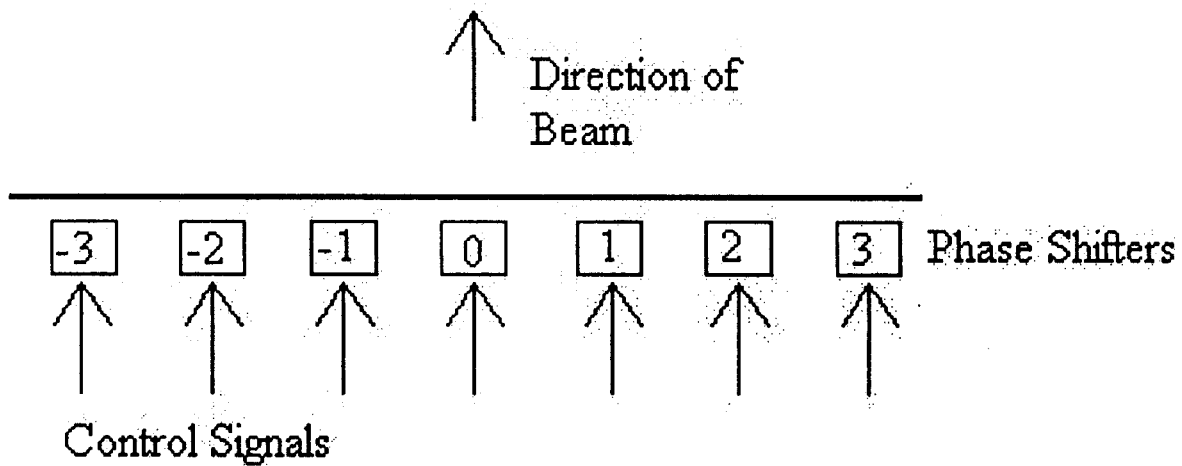
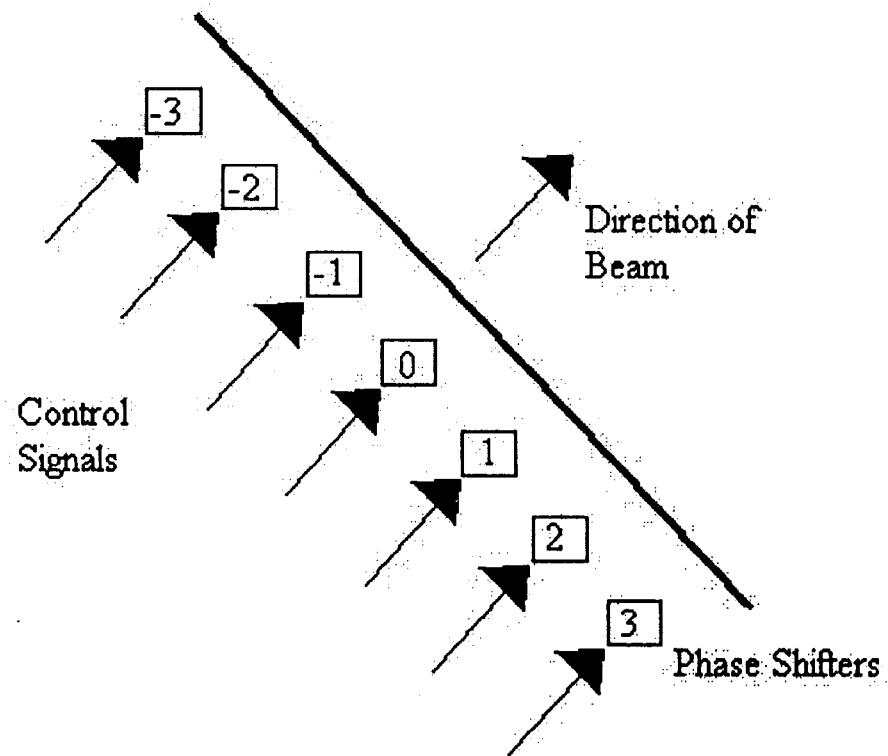
Plate 7. Closeup of the Assembled Antenna (Top).

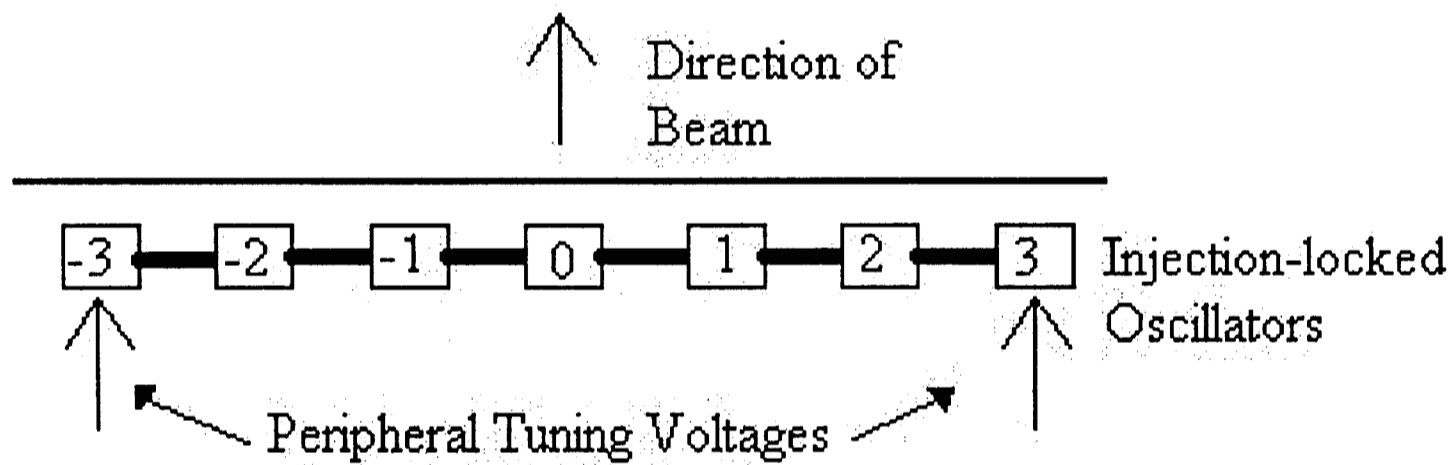
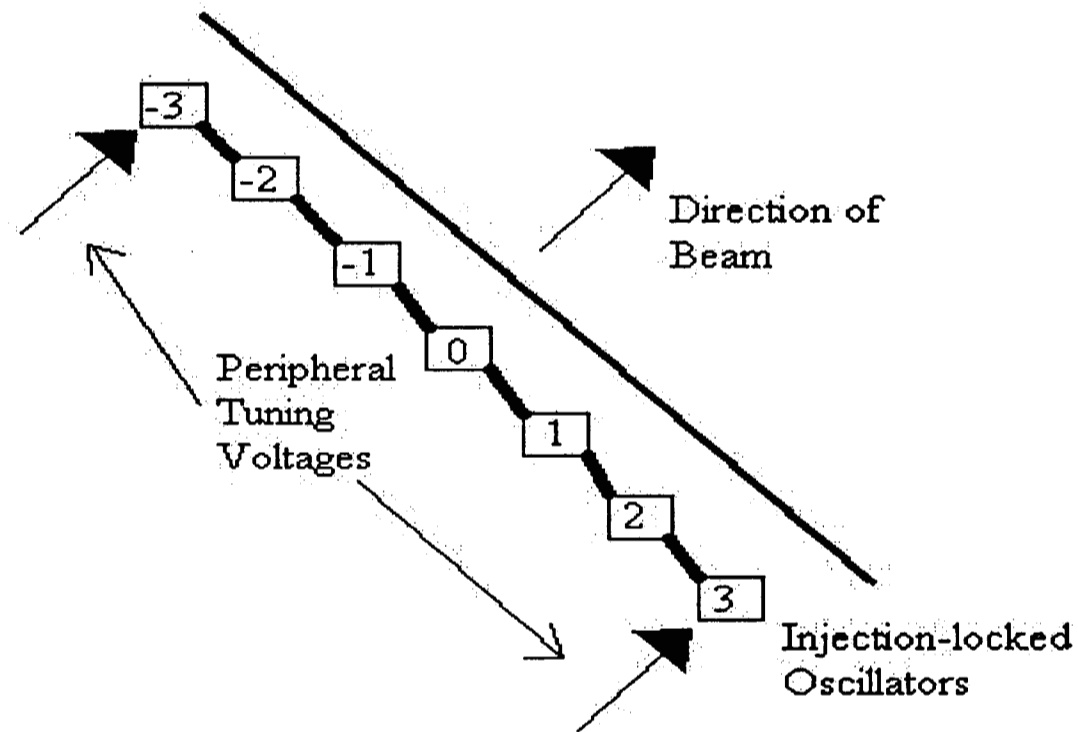


Plate 5. Seven Element Array  
on Range Positioner

# Main Points

- └ Summary of Oscillator Theory
- └ Virtual Instrument - Tuning the Oscillators
- Preliminary Observations in Beam Modulation
- Conclusions
- Acknowledgements & Reference Material

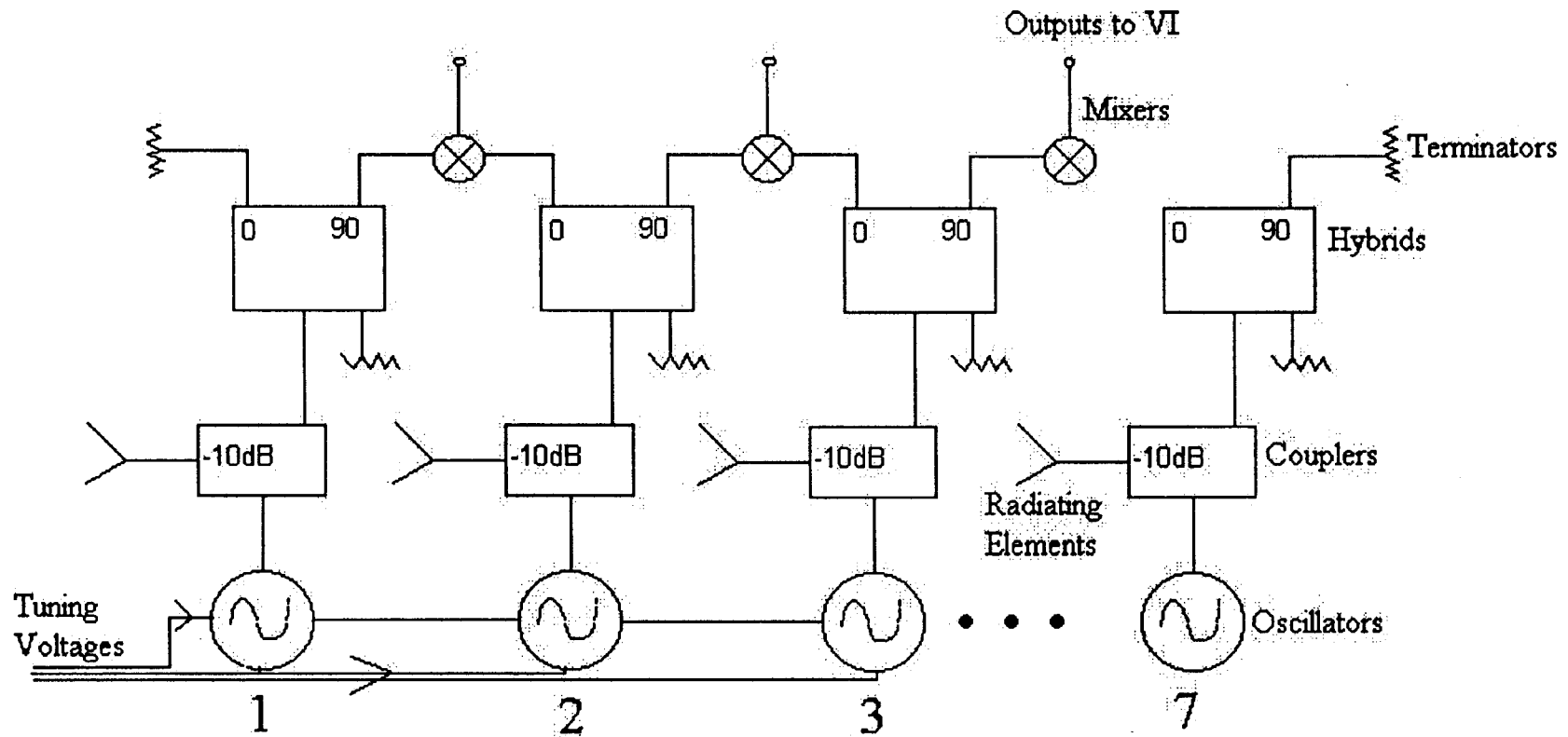




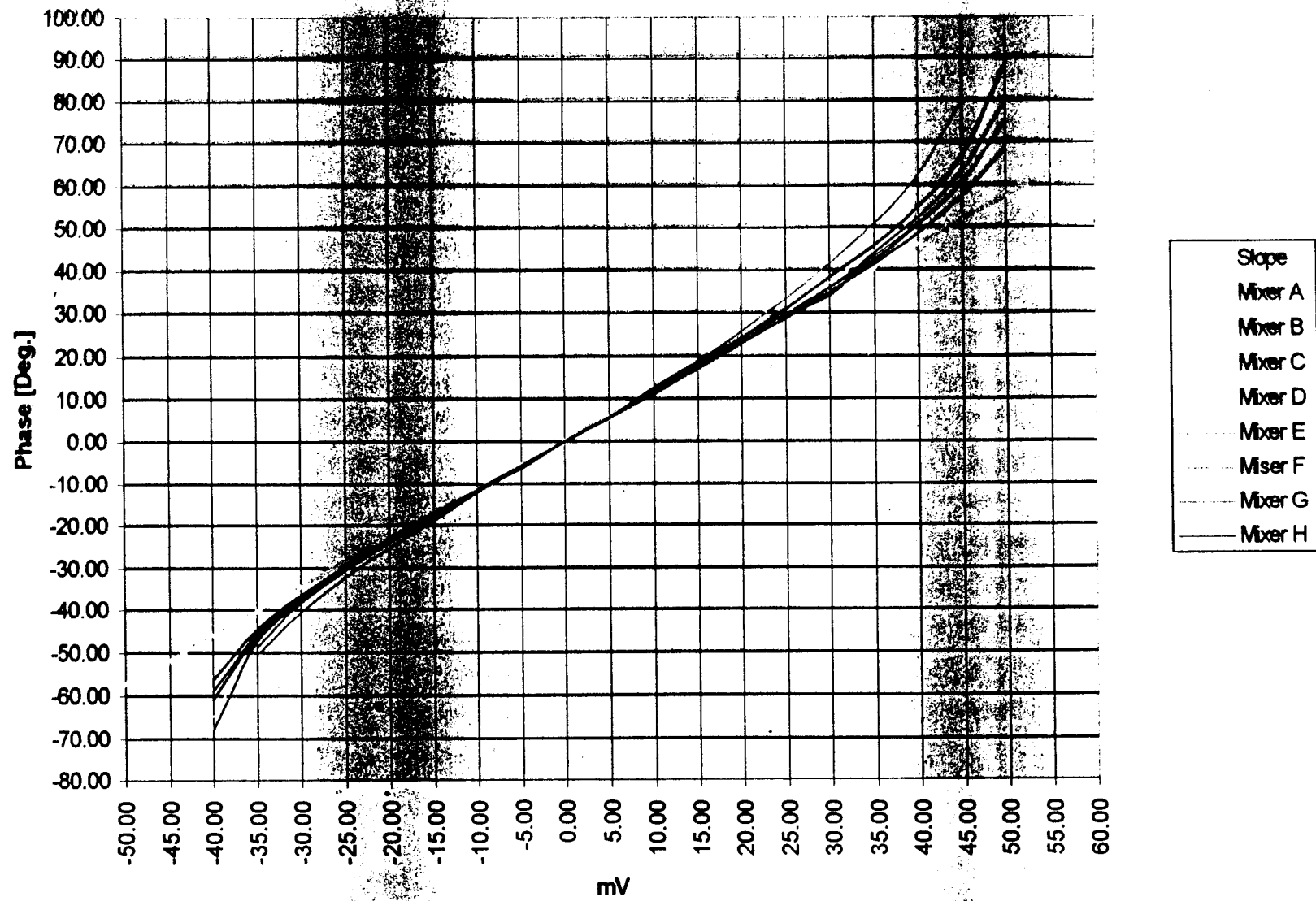
## **OBSERVING TUNING CHARACTERISTICS**

- System needed to observe the effects of the tuning voltages on the oscillators.
- Phase is the parameter responsible for beam steering.
- Need to know the relative phase between each of the oscillators.
- Solution = Mixers

# The Seven-Element Array Oscillator & Mixer Network

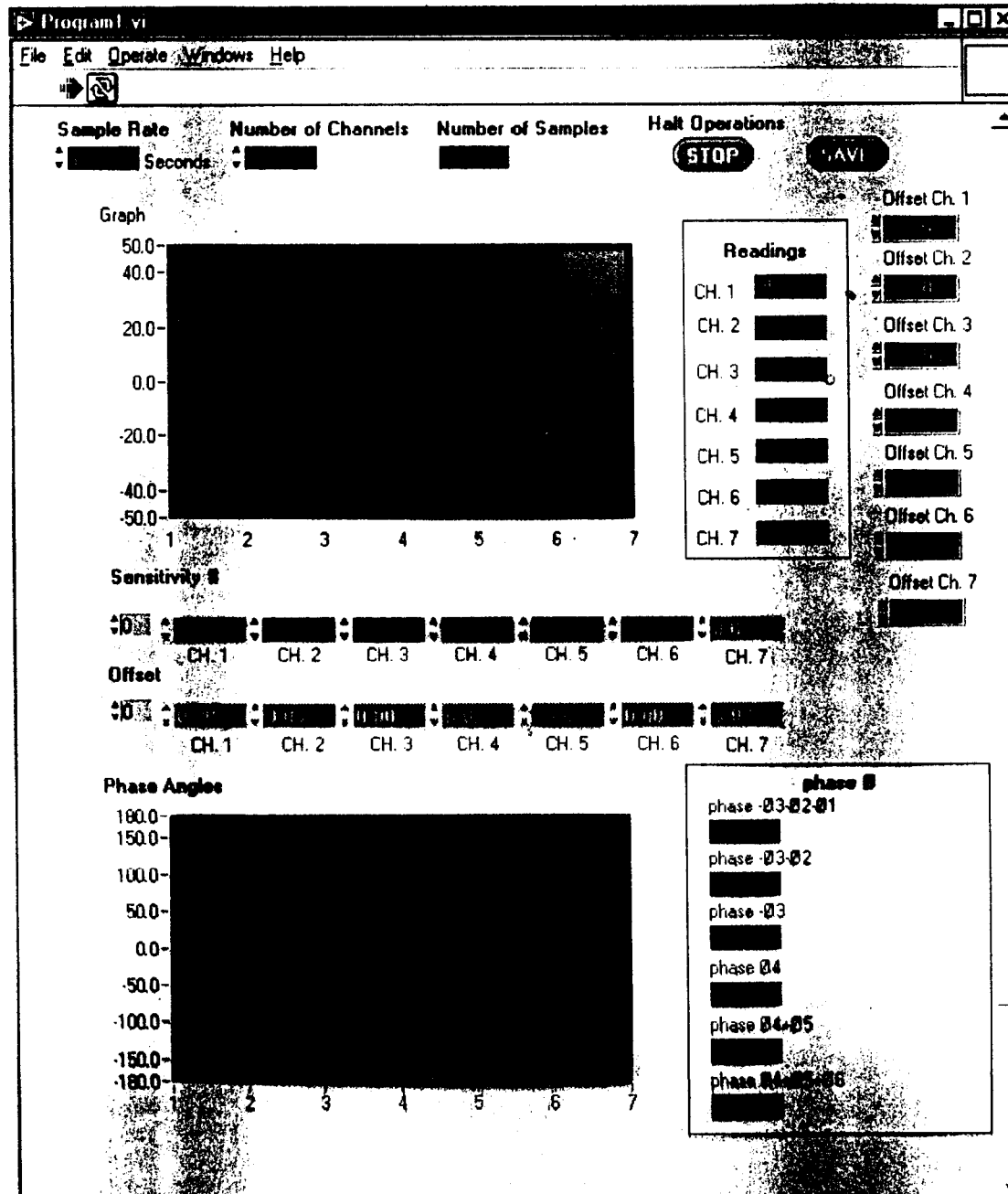


# Mixer Calibration



## **DISPLAYING THE TUNING CHARACTERISTICS**

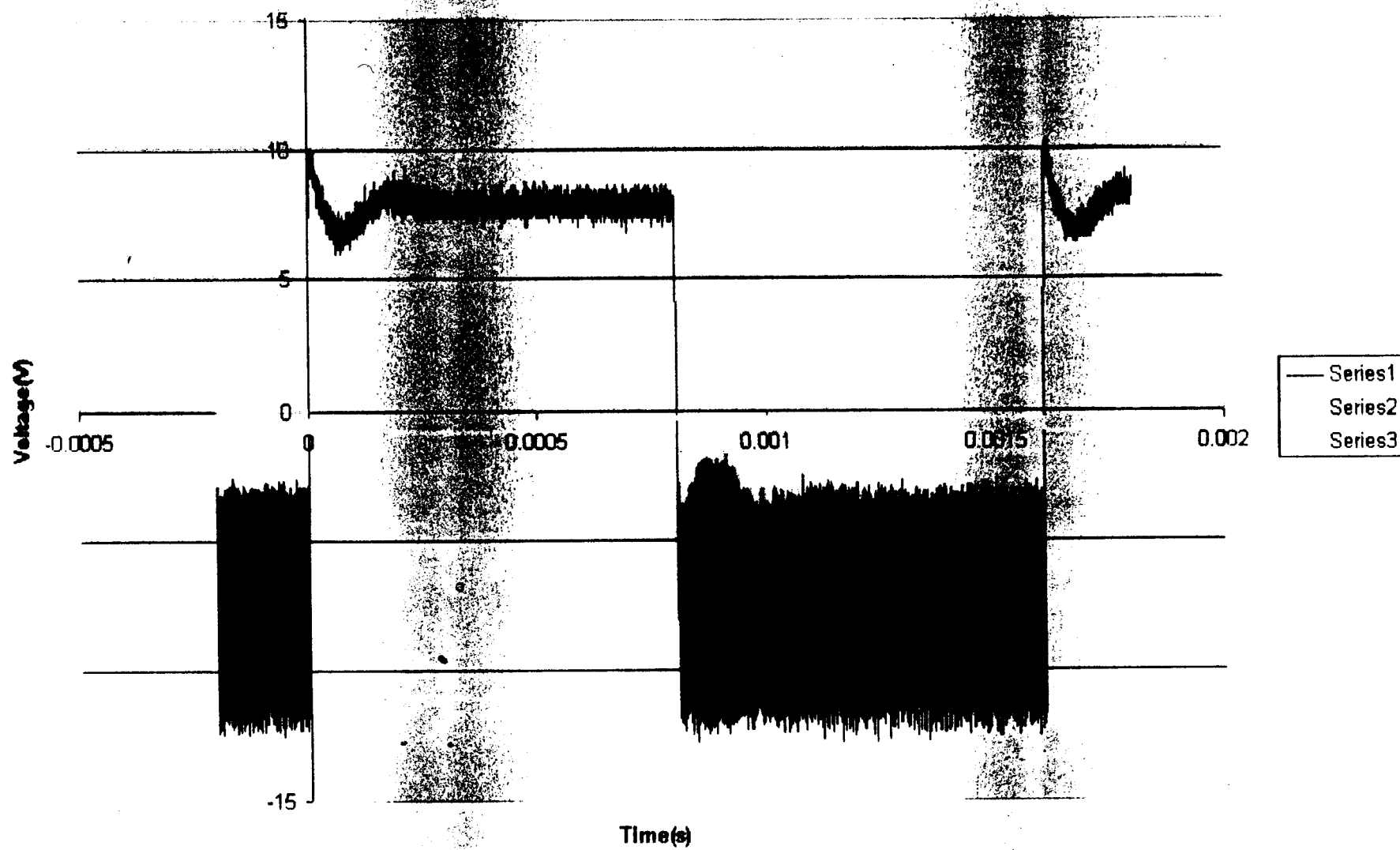
- Virtual Instrument (VI)
  - Samples voltage at the mixer outputs.
  - Displays this voltage in a plot.
  - Converts the sampled voltage to phase.
  - Displays the integrated phase in a plot.
- Advantages:
  - Intuitive observation of oscillator tuning.
  - Changes in tuning are seen in real-time.
  - Tuning of the entire array can be observed.



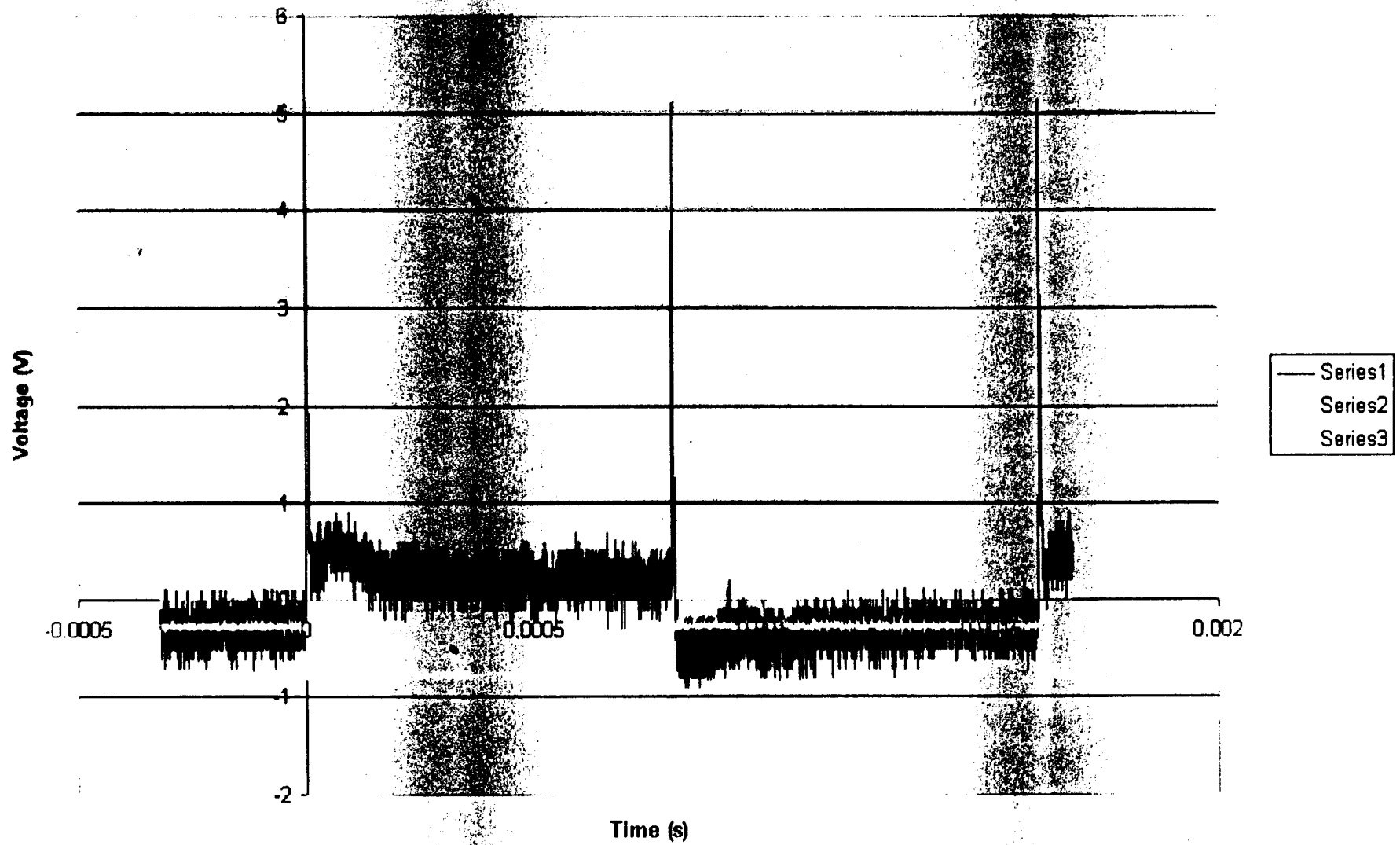
## **MODULATING THE BEAM**

- How do the oscillators and the array react to an applied modulation signal?
- Preliminary modulation achieved using square wave generator and multi-channel scope.
- Behavior displays theoretical predictions.
- Further analysis needed.

# Channels #1 & #2



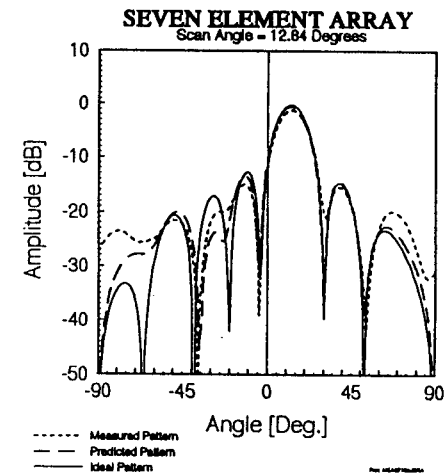
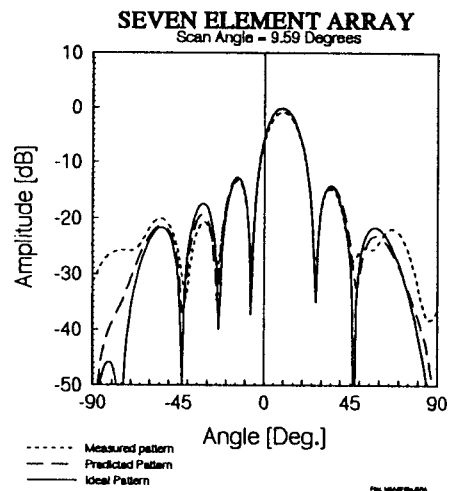
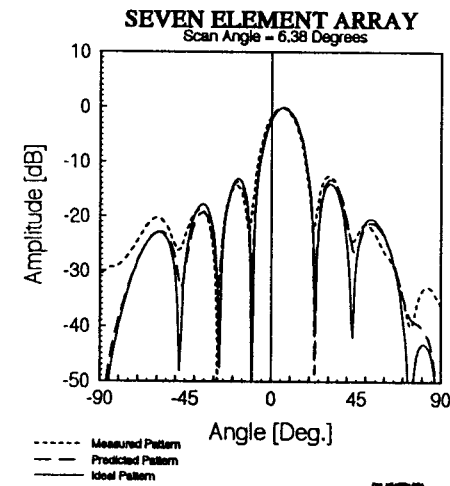
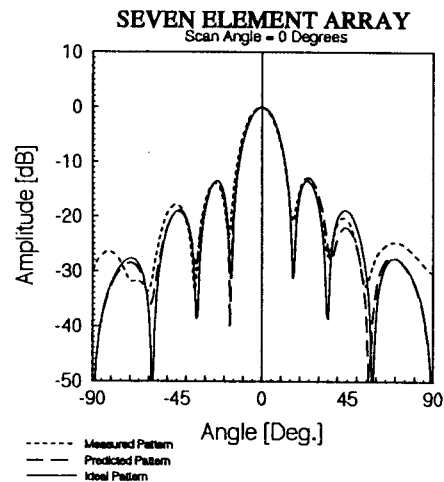
Channel #1 & #2



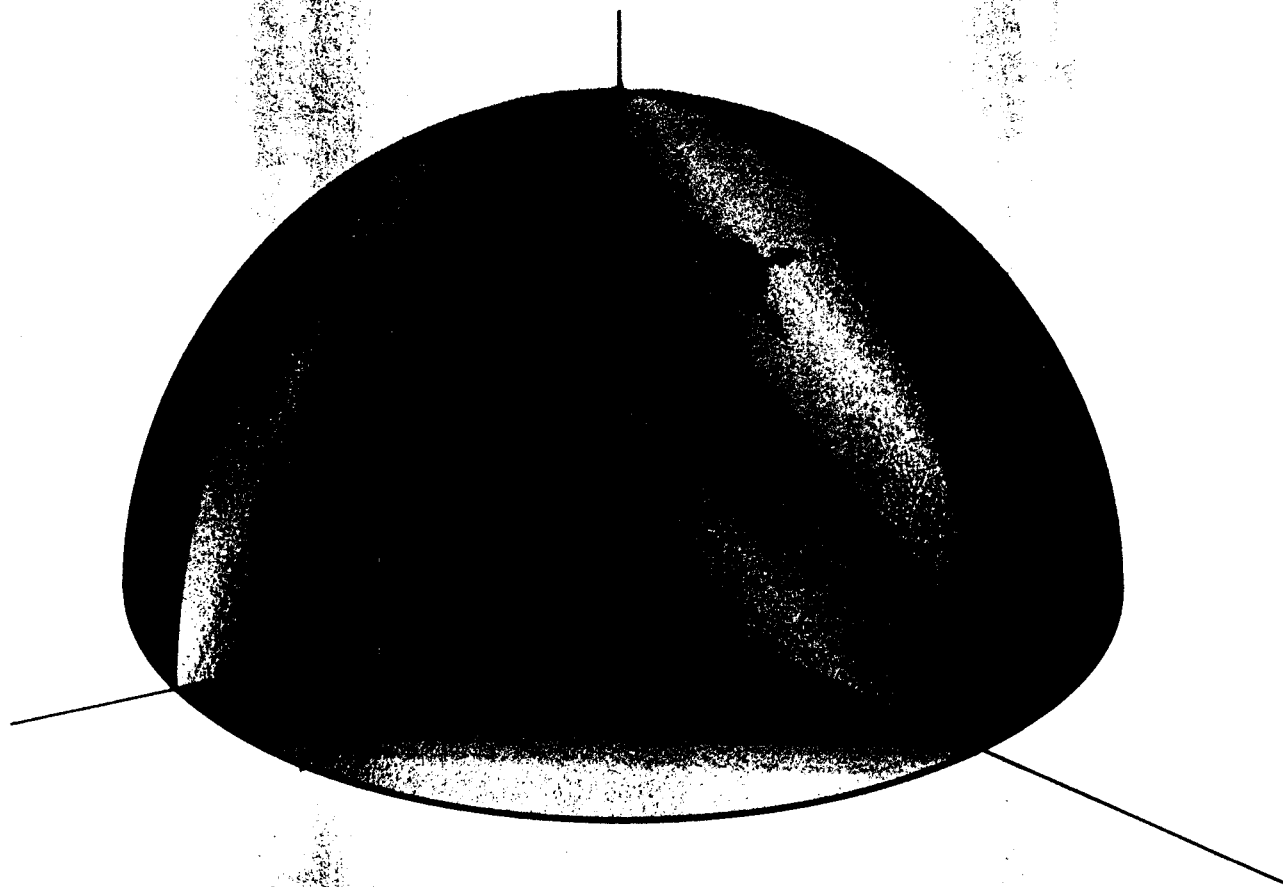
## **CONCLUSIONS**

- Coupled Oscillators are much simpler to use for phased array antennas than phase shifters.
- The use of VI's for data acquisition provides a more efficient and intuitive method for tuning the oscillators and the array.
- Preliminary modulation of the beam correlates to predicted theory.

# Measured and Predicted Patterns of VCO Controlled Array



**PENCIL BEAM  
(HIGH GAIN)**



**FAN BEAM  
(MEDIUM GAIN)**

